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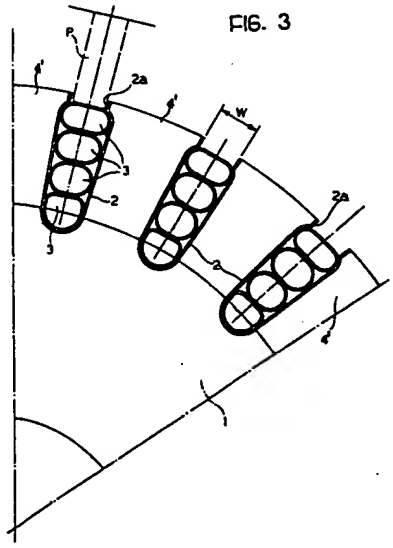
(54) A rotor for an electrical machine, in particular for an electric motor for starting the internal combustion engine of a motor vehicle, and a process for its production

(57) The rotor for an electrical machine comprises a stack of laminations (1) in the periphery of which are provided radial slots (2), each of which accommodates a group of insulated electrical conductors (3) and has a mouth portion (2a) comprising two opposite projections (4'), the distance (W) between which is substantially equal to the diameter of a conductor (3). Inwardly of the mouth portion (2a), the slots (2) have a section which is larger than the diameter of a conductor (3), decreasing radially to the base of the slot (2) in which the section is substantially equal to the diameter of a conductor (3). The conductors (3) are deformed plastically and the flattened portion of the outermost conductor (3) is engaged against the opposite projections (4') preventing the conductors (3) from emerging from the slots (2). The depth of the slots (2) is less than the sum of the diameters of the non-deformed conductors (3) accommodated in the slots (2) themselves.

FIG. 3



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Description

The present invention relates to a rotor of an electrical machine, in particular of a direct current electric motor for starting the internal combustion engine of a motor vehicle.

More specifically, the invention relates to a rotor comprising a stack of laminations, in the periphery of which are provided radial slots, each of which accommodates a group of insulated electrical conductors and has a mouth portion having a width which corresponds substantially to the diameter of a conductor and accommodates the radially outermost conductor of the group.

According to the prior art, in order to fasten the conductors stably and securely in the respective slots in the rotor, these slots are produced with a depth in the radial direction which is markedly greater than the depth which is strictly necessary for accommodating the corresponding electrical conductors. The edges of the slots are thus plastically deformed, usually during stamping operations performed at a given pitch along the slots such that the plastically deformed edges prevent the conductors from escaping from the slots.

As already mentioned, this solution implies that the slots are arranged with a radial depth which is substantially greater than the measurement which would strictly be necessary for guaranteeing the accommodation of the conductors. This is to the detriment of the intensity of the magnetic flux which affects the operation of the rotor.

It has already been proposed in Italian Patent Application No. TO91A000784 of 16 October 1991 in the name of the same applicant , to produce a rotor for an electrical machine, described in Figure 1, comprising a stack of laminations 1 in the periphery of which there are radial slots 2 each of which accommodates a group of insulated electrical conductors 3 and has a mouth portion 2a having a width W which corresponds to the diameter of a conductor 3 and accommodates the radially outermost conductor of this group.

The mouth portion 2a of each slot 2 has opposite recesses 4 and the outermost conductor of each slot 2 is deformed plastically and has a flattened portion, the opposite ends of which engage in the recesses 4, preventing the conductors 3 from escaping from the slot 2.

The slots 2 have a constant width which is substantially equal to the diameter of the conductors 3, except in correspondence with the recesses 4. The height or depth of the slots is substantially equal to the sum of the diameters of the conductors 3 accommodated therein.

The object of the present invention is to provide a rotor of the above-mentioned type which, with respect to what has been described above, maintaining constant the diameter of the rotor, the number of the slots and the number and diameter of the conductors per slot, enables the minimum width of the part made of ferromagnetic material to be increased between slots and the width in the peripheral direction of the teeth defined between pairs of adjacent slots, ultimately obtaining - whilst the other geometrical conditions remain the same - an increase in the cross-section of the rotor which is operationally affected by the magnetic flux and thus an increase in the torque provided by the starter motor, whilst the number of revolutions remains the same.

The present invention achieves the above objects by means of a rotor of the type specified above having the characteristics mentioned specifically in the following claims.

Further characteristics and advantages of the present invention will become clear from the following detailed description, given purely by way of non-limiting example, with reference to the appended drawings, in which:

- Figure 1 (already described) is a partial view in cross-section of a rotor according to the prior art;
- Figure 2 is a partial view in cross-section of a rotor according to the invention in a first assembly phase; and
- Figure 3 is a partial view in cross-section of a rotor according to the invention after assembling operation.

With reference to Figure 2, in which details which are identical or similar to those in Figure 1 are indicated by the same reference numerals, the radial slots 2 (the surfaces of which can be covered with an insulating material according to the prior art) have the mouth portion 2a comprising two opposite projections 4' between which is a distance W substantially corresponding to the diameter of a conductor 3.

The portion of the radial slots 2 inward of the mouth portion 2a has a width in the peripheral sense which is greater than the diameter of a conductor 3; this portion decreases radially until, at the base of the slot 2, it is substantially equal to the diameter of a conductor 3.

As can be seen in Figure 2, the overall depth of th slots 2 is less than the sum of the diameters of the conductors 3 accommodated therein (four in the case of Figures 2 and 3), for which reason a part of the outermost conductor emerges from the slot over almost half the diameter.

By means of a punch P illustrated in dashed lines in Figures 2 and 3, the conductors 3 are plastically deformed, assuming the flattened shape of Figure 3. In this Figure, the conductors 3 are deformed progressively more markedly from the interior towards the exterior of the slots 2 and have cross-sections which are increasingly more flattened. In each slot the opposite ends of the flattened portions of the outermost conductors engage below the opposite projections 4' so as to prevent the conductors 3 emerging either in static conditions or in the more difficult dynamic conditions when the rotor is operating.

A peripheral layer of machining allowance (10 in Figure 2) can then be removed before the armature and the inductor are assembled to form the starter motor.

By means of the characteristics described, in a rotor according to the invention, with the outer diameter of the rotor remaining the same, the minimum width of the iron between slots increases by approximately 15%, the minimum diameter on which the conductors 3 act increases by approximately 10% and it has been confirmed in experiments that the starting torque increases by approximately 10%.

Naturally, the principles of the invention remaining the same, the forms of embodiment and details of production can be widely varied relative to what has been described and illustrated purely by way of non-limiting example, without departing from the scope of the present invention.

Claims

1. A rotor for an electrical machine, in particular for a direct current electric motor for starting the internal combustion engine of a motor vehicle, comprising a stack of laminations (1) in the periphery of which are arranged radial slots (2) each of which accommodates a group of insulated electrical conductors (3) and has a mouth portion (2a) comprising two opposite projections (4') between which is a distance (W) which corresponds substantially to the diameter of a conductor (3), characterised in that the radial slots (2), inwardly of the mouth portion (2a), have a width which is substantially larger than the diameter of a conductor (3), decreasing radially towards the base of the slot, where the section thereof is substantially equal to the diameter of a conductor (3); in that the conductors (3) of each slot (2) are plastically deformed and have flattened transverse portions, the opposite ends of the flattened portions of the outermost conductors (3) engaging below the opposite projections (4'), such that the conductors (3) are prevented from emerging from the slots (2); and in that the overall length of each slot (2) is less than the sum of the diameters of the non-deformed conductors (3) accommodated in the slots (2) themselves.

2. A process for producing a rotor for an electrical machine, in particular for a direct current electric motor for starting an internal combustion engine for a motor vehicle, comprising the operations of:

   - disposing a stack of laminations (1) in the periphery of which are provided radial slots (2) for accommodating a group of insulated electrical conductors (3), each slot having a mouth portion (2a) comprising two opposite projections (4'), between which is a distance (W) which corresponds substantially to the diameter of a conductor (3); and
   - disposing the conductors (3) in the slots (2) of the stack of laminations (1);

   the process being characterised in that the slots (2) are disposed such that, inwardly of the mouth portion (2a), they have a width which is substantially greater than the diameter of a conductor (3), decreasing radially toward the base of the slot (2) where its portion is substantially equal to the diameter of a conductor (3); in that the conductors (3) are plastically deformed in the slots (2) such that they have flattened transverse portions, the opposite ends of the flattened transverse portions of the conductors (3) engaging below the opposite projections (4') such that they prevent the conductors (3) from emerging from the slot (2); and in that the overall length of each slot (2) is less than the sum of the diameters of the non-deformed conductors (3) accommodated in the slot (2) itself.

FIG. 1

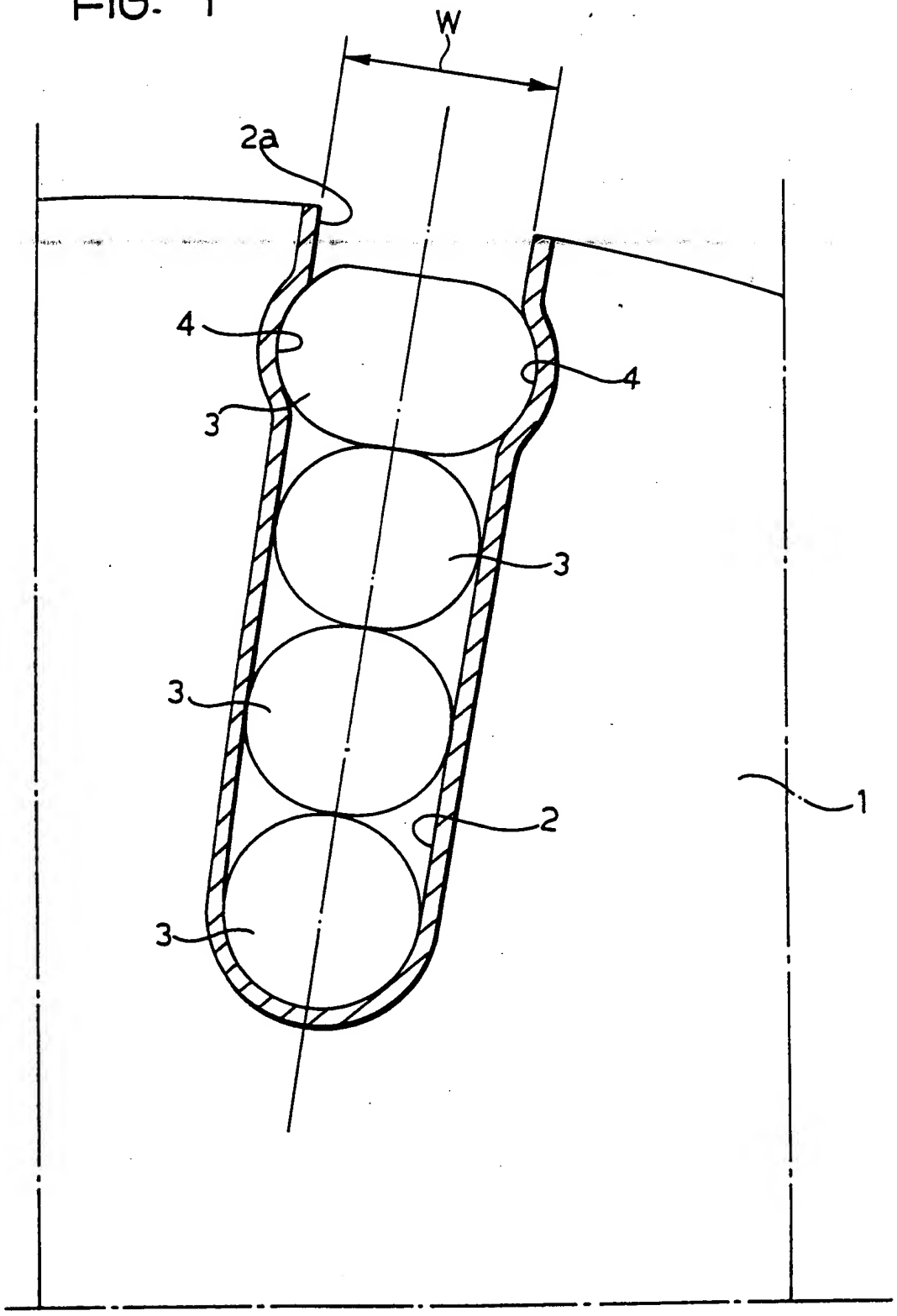


FIG. 2

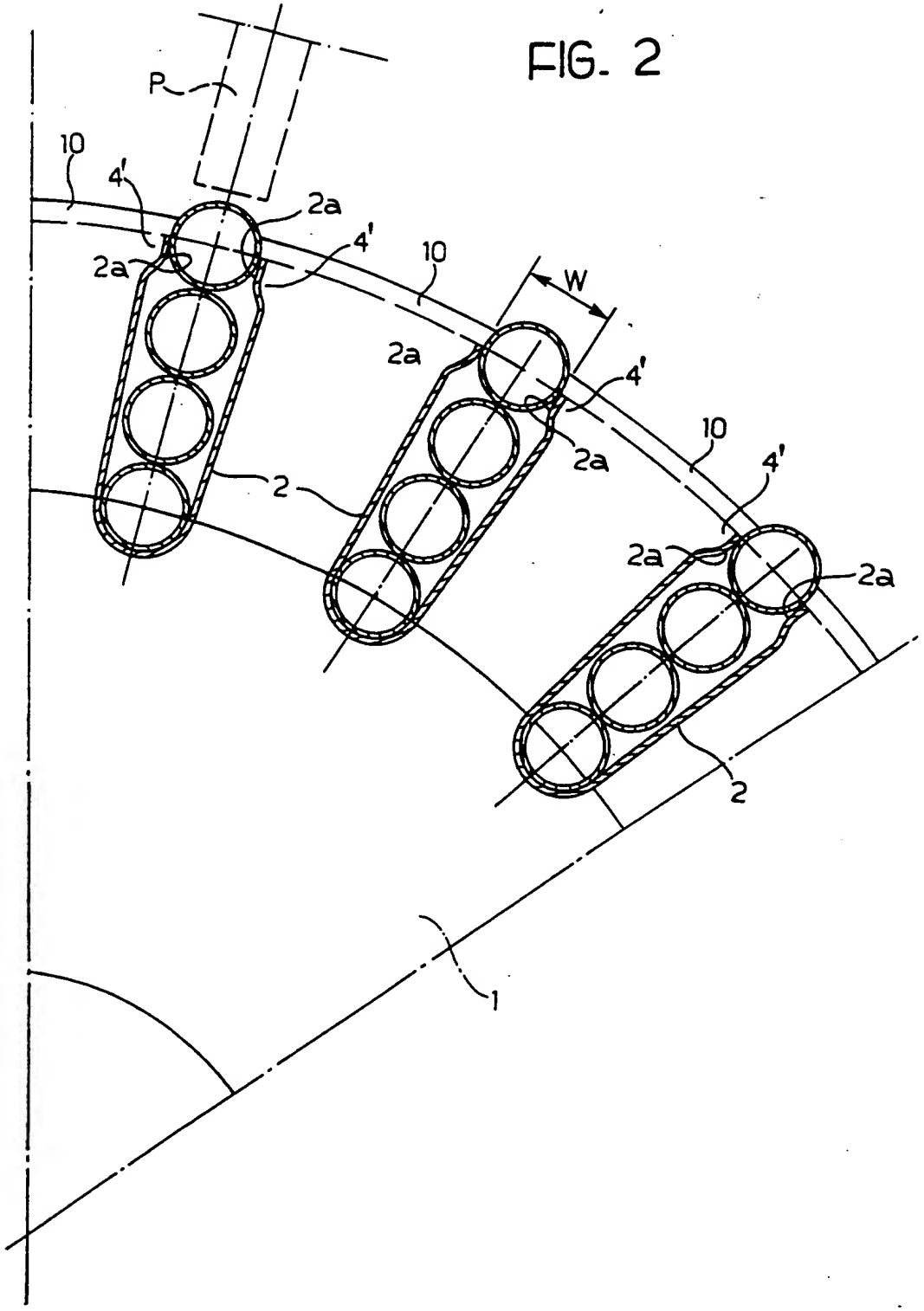
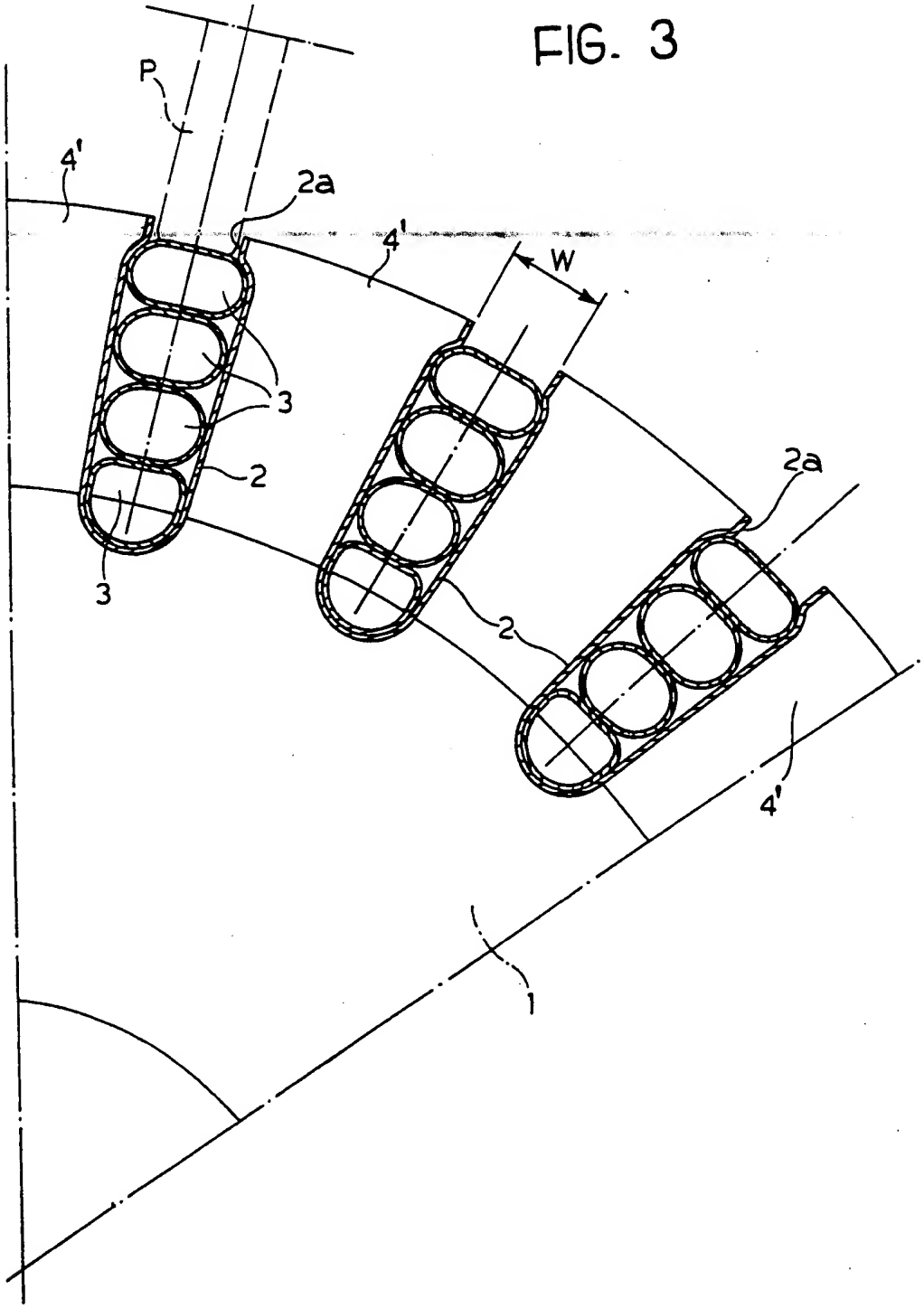


FIG. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 95 11 1328

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	FR-A-1 573 177 (COMPAGNIE ÉLECTROMÉCANIQUE) 4 July 1969 * page 2, line 14 - line 24 * * page 4, line 9 - line 24; figures 1,2,11,12 *	1,2	H02K3/48 H02K3/12
Y	DEUTSCHE ELEKTROTECHNIK, vol. 13, no. 5, May 1959 BERLIN, pages 165-168, R. KRETZCHMANN '"Gesichtspunkte für die herstellung und auswahl von explosionsgeschützten drehstrom-asynchronmotoren"' * page 165, right column, line 1 - line 17; figure 1 *	1,2	
A	DE-A-33 47 195 (HITACHI LTD) 5 July 1984 * page 12, paragraph 6 - page 13, paragraph 2; figures 6,7 *	1,2	
A	DE-C-572 619 (BROWN BOVERI) 29 October 1929 * page 1, line 46 - page 2, line 32; figures 1-3 *	1,2	TECHNICAL FIELDS SEARCHED (Int.Cl.6) H02K
A	FR-A-2 415 385 (BOSCH GMBH ROBERT) 17 August 1979 * page 2, line 4 - line 25; figures 1,2 *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 November 1995	Zoukas, E

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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